STUDY SPACE-TEMPORAL OF SÃO LUIS (UPAON-AÇU) ISLAND: DOCUMENTATION AND ANALYSIS OF LANDSCAPE AND CULTURAL HERITAGE

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Article Information

Keywords:
Upaon-açu,
Cultural Heritage,
Landscape,
Spatial Data Infrastructure (SDI),
Geograghic Information System (GIS)

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Abstract

This work has as its main objective conduct a graphic and visual study on the evolution of the landscape in São Luis Island, located in the Department of Maranhão (Brazil). The methodology used is based on a holistic approach to the conception of landscape and subsequent planning of the territory. In a first phase, we proceeded to the identification and mapping of cartography and images over time. To do this is we have pre-selected four sites in the studied area. They are the municipalities that form the island of Sao Luis: Raposa, São José de Ribamar, Paço do Lumiar and São Luis. These places have been documented and analyses from two perspectives: geological-geomorphological perspective in its natural conception of space and the prospect of the occupation of the soil in the model of development followed by that territory. The main result is the creation of an information system that can serve as geo-visual support for the defense of the cultural heritage, and thus help in the decisions of future planning for the study area.

1. Introduction

The city of Sao Luis on the island of the same name is the capital of the State of Maranhão (Brazil), which has experienced a continuous expansion, as well as a diversification of the forms of occupation of its physical space. This is due, among other factors, to its disorderly population growth. That is why there were disorders in the region, for example has changed its configuration in terms of the ratio of the original vegetation and/or green areas. Also the forms of occupation and exploitation of the resources of land, water and forest, resulting in greater social inequality, environmental crimes, the destruction of homes, finally, the denial of human rights [1].

The complex development of urbanization in recent years, in addition to the consumption of resources of the island, have aggravated already if deteriorated situation of society that lives there. Factors such as inadequate distribution of space contributed to the development of the sources of environmental pollution, both of insalubrity in the maintenance of the natural system, in addition to expose to various risks to the poor [2]. The perpetuating of these impacts introduce new issues in a setting of distortions of what would be the well-being and quality of life; for this reason, an appropriate organization of space determined by consistent public policies, as well as the modes of production and the development of the territory [3].

In this sense, there is a need to obtain more specific data to study the dynamics of the landscape and the occupation of the island, using geo-processing tools that contribute to the follow-up of this expansion, the cartography of the disturbed areas and vegetation as well as its remaining environmental impacts in seeking to maximize the results obtained with the use of this technology [4].

In this context, this paper tries to be a geo-visual update of the local landscape features to enrich the existing knowledge on urban sprawl in this study area. On the other hand, contains some warnings or alerts about gravity in the consumption of resources and expansion of urban areas. In this sense, changes in the perception of the landscape are obvious, so the vegetation of the island has been transforming or disappearing.

1.1 Objective

The main objective is the creation of an information system that can serve as geo-visual support to better understand the evolution of the landscape. In this context is it can collaborate in the defense of the cultural heritage and in the decisions of future planning for the study area. In a first phase we try to analyze a landscape territory for your better understanding, in order to have data prior to possible future interventions covering the strengths of the landscape study.

Understand, draw and represent the main elements of the landscape of the area referred to by the accessible digital resources and new development.

1.2 Study area

The island of Maranhão or Upaon Acu is located to the North of the State of Maranhão, Northeast Brazil, marked by the geographical coordinates 2º 24´ 10" and 2º 46´ 37" South latitude and 44º 22´ 39" and 44º 22´ 39" W, with a total area of 1410,015 km^2 [5] (Fig 1).

The territory of the island is divided into four municipalities that make up the metropolitan region of Sao Luis: Raposa, São Luis, São José de Ribamar and Paço do Lumiar [6]. Today the area is very changed; its natural vegetation along these decades has been replaced by various building elements and buildings. The root cause has been the significant increase in the population of the island and consequential changes to the land use.

Still, they are today visible areas of mangroves, babaçu (secondary vegetation) and some riparian vegetation (Fig 4). This type of ecosystems is based on four main kinds of soils: Latosols red, Neosols Quartzarenics, Argisols, and Gleysols [7].

According to the Brazilian Institute of Geography and Statistics [5], the municipality of São Luis in 2010 had a population of 1.309.330 habitants. The city is the biggest of the island. The climate according to the Koppen classification is Aw´, tropical rainforest, with a predominance of precipitation in the months of January to April and this is due to that the city is close to the area of Inter-tropical Convergence (ZCIT) and the average annual temperature is around 28ºC. The island contains some relevant hydrography rivers, the main are Anil, Bacanga, Tibiri, Paciencia, Maracanã, Calhau, Pimenta, Coqueiro and Cachorros. They are small rivers which flow into the areas of dunes, beaches and mangroves. The two largest are the Anil River having 12,63 km in length and the Bacanga of 22 km to its mouth at the Bay of San Marcos, which is characterized by its area of influence covered mangrove estuaries [8].

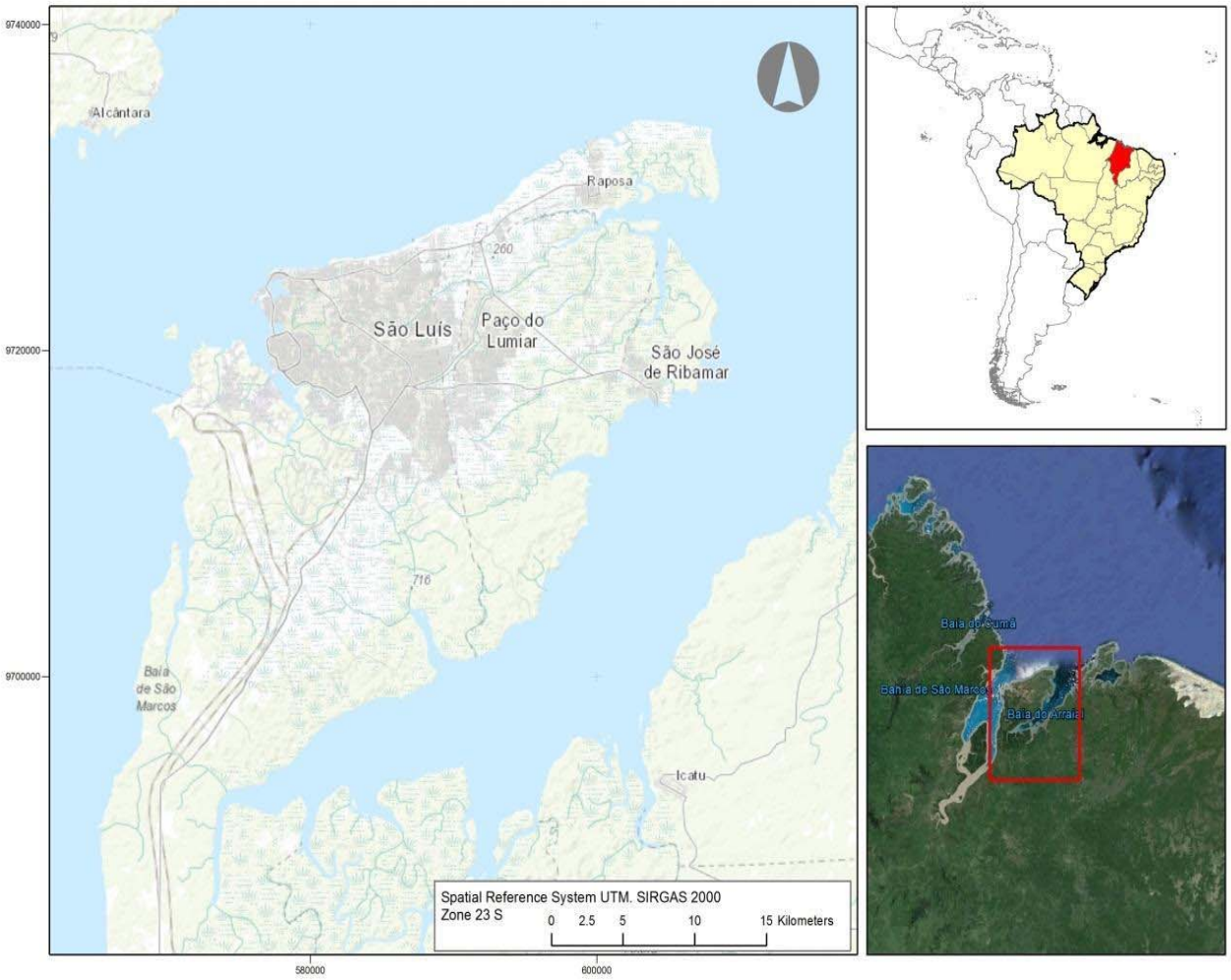

Fig.1 Location of study area. Maranhão Island or Upaon Açu north of Maranhão (northeast Brazil). Spatial Reference System SIRGAS 2000 UTM zone 23S

2 Methodology

This study relies partially on the methodology of Geo-design proposed by Carl Steinitz (2012) [9], work that addresses methods of comprehensive planning of the territory. This approach identifies the points in common that exist between the Sciences of the territory and methods for projecting, is actually an operational framework to build a better future.

On the other hand, this work is also based on criteria described in the book of Drawing the landscape that is lost (a spatial model of agricultural heritage) by Esther Isabel Prada Llorente (2014) [10], as well as in the specific experience in this field of Geovisualization Unique Spaces and Heritage (GESyP) research group.

The successive transformations and the human factor. Different levels of integration scales linking both the life experience of the community itself through the images and the text set out to understand the landscape. A landscape "source" that teaches us how a particular social group built the place (Fig. 2).

Steinitz proposes and organizes the case studies into three different groups geodiseño. Proactive, participatory and sequential. Geodiseño equipment assumed to be able to develop a proposal for the future of the study area. Constraints and combinatorial methods where the team geodiseño not certain about the fundamental initial decision. Model based, agent-based and optimized. Mixed model that includes the sequential method and based on agents. In these models geodiseño team you understand the rules that guide the process of change. For this work the model of participatory change is proposed, potentially more democratic than the other models. (Fig. 3).

The created information system contains different displays and photo-interpretations of the study on the island including abiotic analysis: geological and geomorphological issues relating to topography, hydrography and soil science; biotic analysis: natural vegetation (forest, mangle, scrubland and riparian vegetation). Plant species with photographs and diagrams or drawings of its structure, botanical data and environmental characteristics; rural anthropic analysis representing networks of roads and/or trails as well as a mosaic of subdivisions; anthropic urban analysis representing each town and scattered buildings; study on the toponymy of local, reflecting those place names that describe the main abiotic, biotic, anthropic and cultural heritage elements.

They are set at least three areas scalar for this type of photo-interpretation, territorial scale ranging Department of Maranhão to the delimitation of the island of Sao Luis. The scale of the municipality which includes the four municipalities surveyed in the island itself: Sao Luis, Paso de Lumiar and São José de Ribamar and Raposa. Finally, the analysis focuses on which we call urban scale, which includes the settlements of people raised and built to date in each of the four municipalities we studied. Designed information system contains each of the three areas scalar submitted to the workflow may be seen in (Fig. 4). Following the guidelines of the participatory model applied to the region of Osa, Costa Rica [9], the proposal is representation to the process and evaluation, through change in the landscape, valuing the social and economic impacts to arrive at decisions that have to do with future patterns in the use of the soil and of the cultural heritage.

For the development of the work, has been mainly used the software ArcMap desktop backgrounds and images in digital format, with different characteristics. The development of this project, at this stage has been developed in Spain, it has forced us to use sources of information of the infrastructure of spatial data of Brazil, accessible via the web, at a later stage will be completed with photo-interpretation and specific cartography generated on the own land.

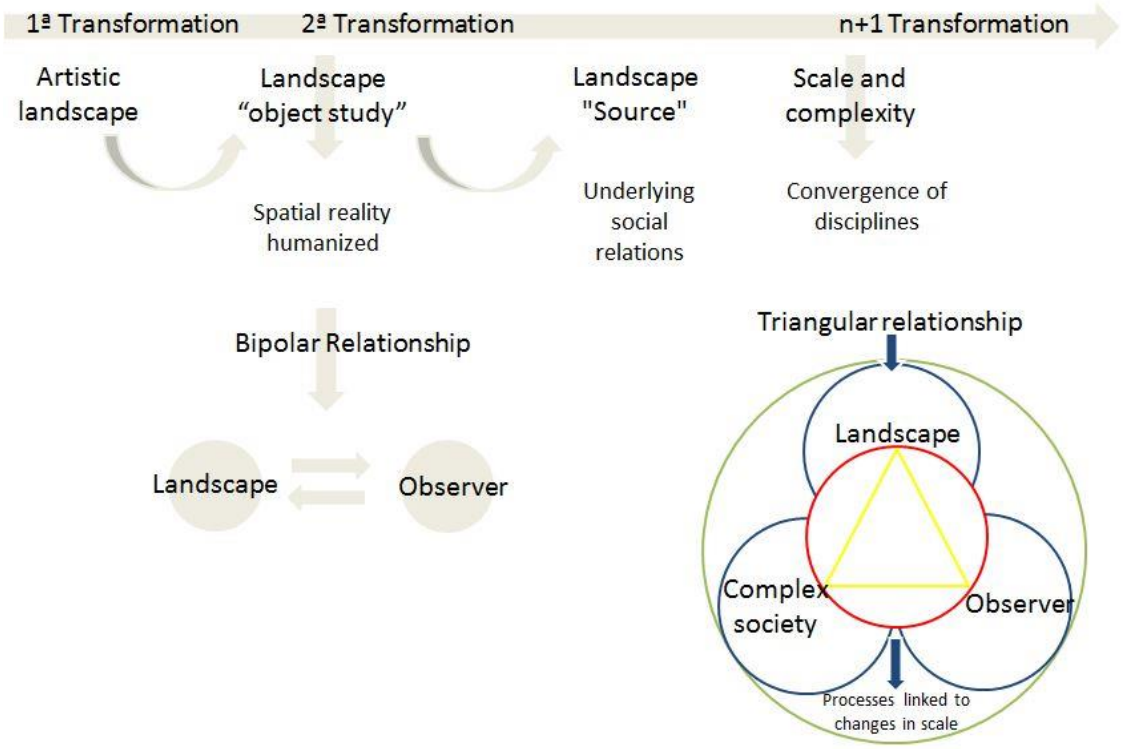

Fig. 2 Landscape as an objective and external perception, the landscape as a source and insight. Map of the transformations in the formation of the modern concept of scenery. In Atlas of agricultural landscapes of Spain. Esther L. Prada

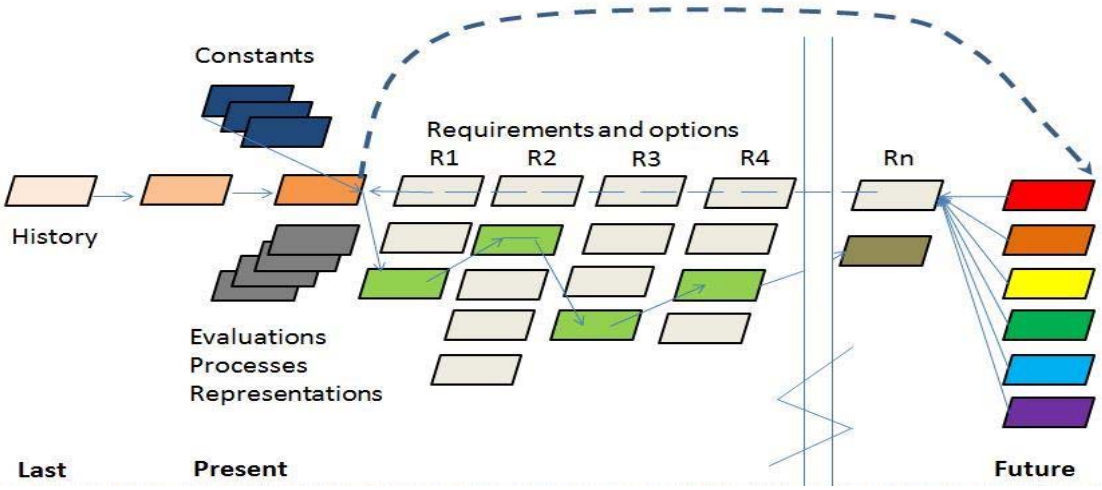

Fig. 3 The participatory model change considers the ideas of each collaborator. Any disagreement between the initial project team members are indicated by "future" of different color. Bibliographic source: C. Steinitz

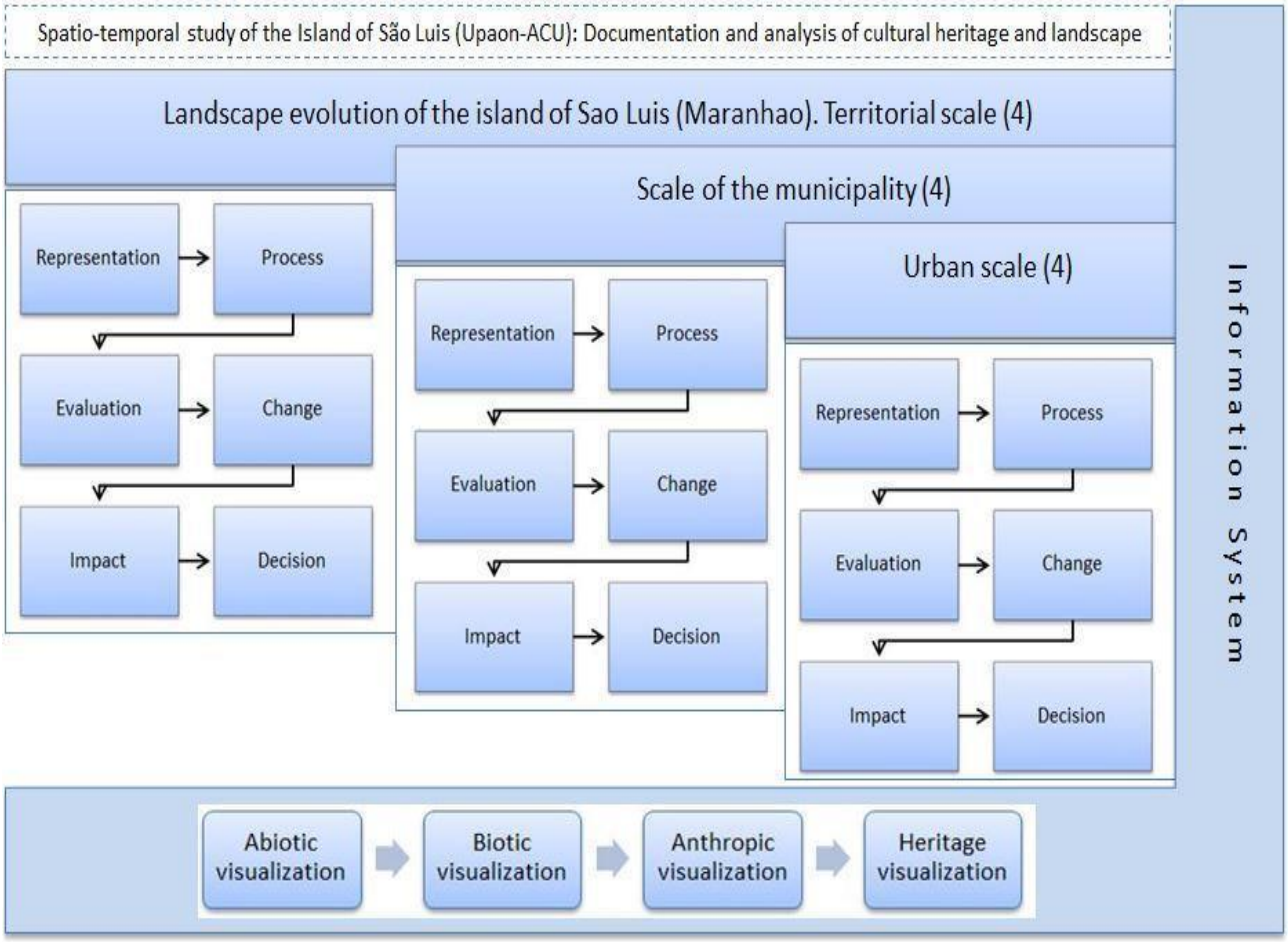

Fig.4 Methodology used in this study (from Steinitz and Prada)

3 Result and Discussion

The island of São Luis (Fig. 3, section a) has suffered a great increase in population during the last decades, this has affected the structure and characterization of the local landscape. According to the Brazilian Geography and Statistics Institute Studies (IBGE) [9], the estimate for the population in 2014 on the island is 1,3 million, an increase of 59,4% in relation to the census in the year of 1991, which had a population of 820 thousand habitants and 138,1% in relation to population of 1690 which was about 10 thousand habitants. This great population growth according to Gomes [11] (2008), can provide a series of environmental problems, such as intensive land use in the central areas, replacement of green areas by built-up areas, proliferation of settlements that do not consider the physical restrictions of the areas, destruction of areas of preservation and loss of biodiversity, both in the flora as fauna, pollution of water resources, among others. All these problems are increasingly visible in the reality of the island. In this sense has been represented in the (Fig. 5, section b) with the four municipality's division: 1. 1. Sao Luis, 2. Sao Jose de Ribamar, 3. Paço de Lumiar y 4. Raposa. Variation of land use for residence in the last 35 years, (1980-2015) of is reflected in Brown's less than higher intensity. In addition this graphic representation contains a straight line that reflects the profile altitude in the visible representation in b´ (SW/NE), he notes the slight unevenness which exists on the island.

The rapid population growth has been fueled by several factors, such as the rural exodus, the high number of children by couples (3-5), persons from other Brazilian States which are situated in this area. On the other hand, there are factors that have influenced directly the process of consumption of natural resources, also contributed to the deformation of the landscape. These disruptive elements have proliferated in this context due to the lack of both urban and rural planning. The study made by Amorim [1] where he made a temporary analysis of the years from 1984 until 2010 on the use and coverage of the ground on the island, have shown that growth and occupation of the disordered population has led to environmental degradation and expansion of the risks of habitability of the citizens. In this regard, it was found that in the period under study there was an increase of 143 of the population, causing a reduction of the Green surface of the island. Amorim [1] relates that will yield a decrease in the areas of scrub banks (45,50%), scrub secondary (17,83%) and mangrove (15,02%). And on the coast, in the areas of dominance of banks of sand, because the natural dynamics, interactions were inconspicuous (1,5%).

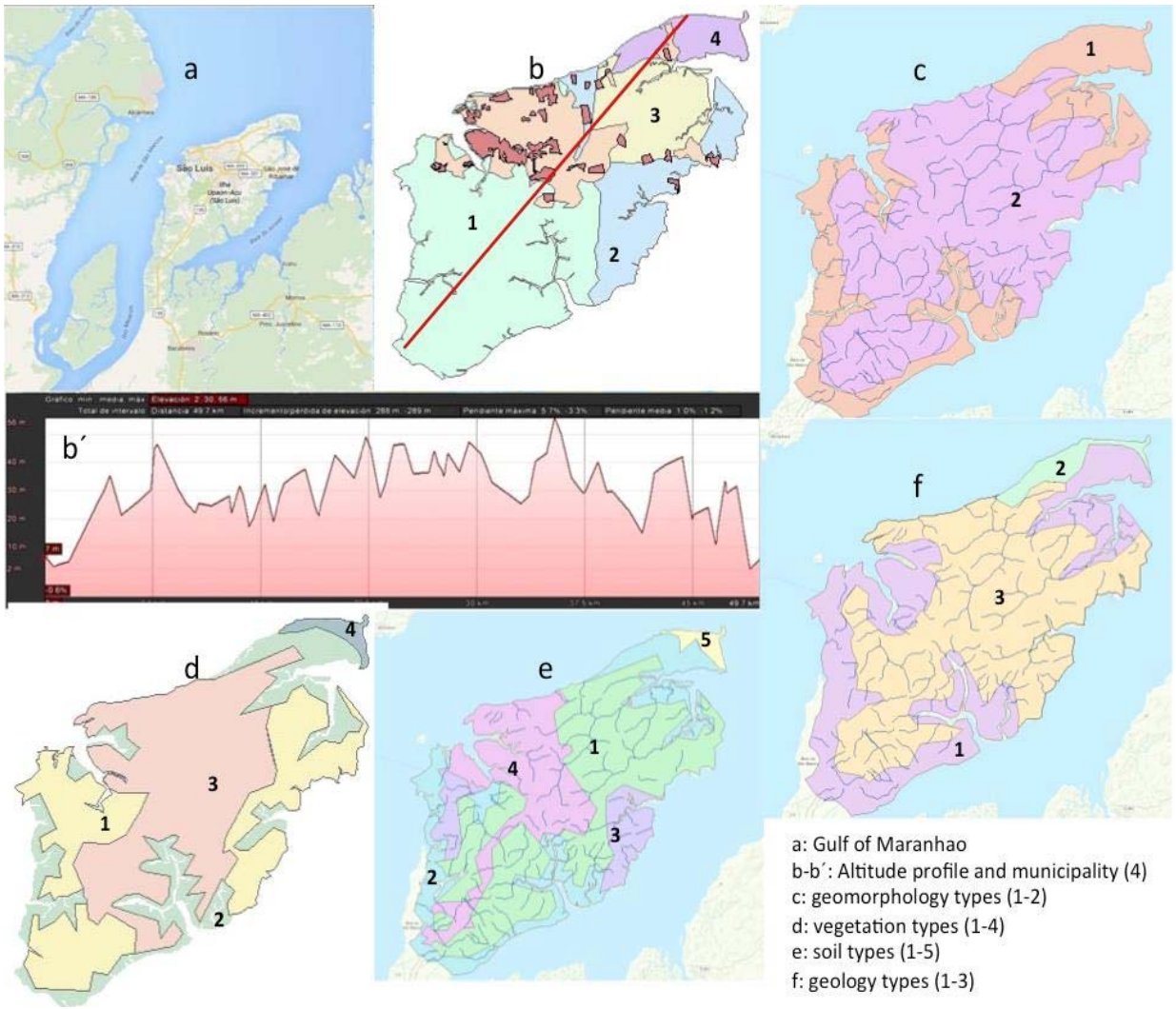

Fig. 5 Gulf of Maranhao/Sao Luis: plot types and visualization major geophysical factors.

In relation to geomorphological studies in this region, various authors have made contributions over time, highlighting [12-13-14-15-16-17-18-19-20-21-22-23-24].

However, many of these works contain data on small areas or specific parts of the island, as the works contained in the Radambrasil project, which was published in 1973. This study included a work of topographic data of geology, geomorphology, soils, vegetation and potential use of the land, finally, in the year of 1998 was published a documentary related to geomorphological characterization of São Luis Island, but did not include the taxonomic analysis of the relief.

São Luis Island is located in the central position in the Maranhense Gulf. According to contributions as [12], the Maranhense Gulf suffered physiognomics changes since its genesis, related to changes in relative sea level and tectonic processes. In short, was not the lifting of the coastal strip, in the Pliocene, which results in the overprint of the sewer system and barriers against erosion, followed by a new uprising with the resumption of erosion and deepening of valleys at a lower level.

In the Pleistocene, came a marine regression, resulting in a new configuration of the bays of San Marcos and San Jose, insulation Maranhão Island and leaving as a witness in the continent in the marine plain Perizes.

At the end of the Pleistocene, there was a new uprising of less intensity and a marine transgression moderate, responsible for the redefinition of the morphology of Golfão Maranhão. Later there were small changes in mean sea level. From the geomorphologic point of view as shown in (Fig. 5, section c) distinguishes two structural domains: (1) tabuleiros costeiros (coastal plains with predominance of sedimentary basins) and (2) coastal mangroves with Quaternary sedimentary deposits. From the geological point of view shown in (Fig. 5, section f) three types of domains: (1) deposits of swamps and mangroves holocénicos, (2) marine deposits of the coast and (3) typical maranhense region Itapecuru formation, typical formation of the region maranhense.

In Fig. 5, section e, they have represented the five main types of soils: (1) Argisol yellow Dystrophic, (2) Glysol tiomorfico orthic, (3) Latosol yellow Dystrophic, (4) urbanized Area, and (5) Neosol Quartzarenico ortico.

The arrival of the Pindaré-Mirim and Mearim rivers make up the large estuary that already surrounds the so-called crab island in the Bay of San Marcos. On the other side of the island of Maranhão, in the eastern part, the Bay of Arraial is located. The slope of the lower Mearim is insignificant and the influence of the sea in these conditions is constant and incisive in such estuaries that also facilitates the intrusion of the tides.

On the other hand the river bed degradation is evident with deforestation, with discharges of the domestic and industrial wastewater, the lack of regulation of landfill sites and mineral extractions have influenced the removal of silt and clay. In the (Fig. 5, section d) are four predominant vegetation types on the island: (1) Open forest of the Highlands with secondary vegetation. (2) Pioneer formations with fluvial and maritime influences (mangrove) (3) Forest open upland agricultural guidance and training (4) Pioneer with maritime influences on shrub-like domain.

That perception of the landscape in the top soils are sandy or loamy, textured depth calcareous intrusions and quartzite are already. In these regions of Amazonian domain are known the incessant fire linked to different agro-forestry and mining practices. This coupled with the rains, which are constant in the region; end up intensely damaging increasingly unprotected soil by indiscriminate logging. The result is the decrease of nutrients, loss of humus, important for the fertility of the vegetation [25].

It seems obvious that human influence and/or geographical determinism are decisive factors in an analysis of these characteristics. In a territory as the studied the physical evolution of the space is consistent with these aspects and contributes to the development and configuration of the landscape.

The trend is a feature that is quantified and is represented in the corresponding map. It affects two or more periods of time and is used for each area scale. At the end the trends for each case study will provide complexity, stability, regressive, progressive and will be positive or negative [26]. Relate the abiotic evolution or Geophysics of the island with trends of biotic and anthropic character through maps, graphs and images seem to confirm elements and information that are already known [27].

Is included (Fig. 6) with four representative images of four domains corresponding to the four studied municipal districts. They reflect processes geophysical, biogeographic and urban changes and trends assessed and inventoried.

Fig. 6 Images corresponding to the four municipalities studied: a) Raposa coastal dunes. b) Agricultural practices in the field of Paço de Lumiar. c) Tibiri TajaÇuaba river bank vegetation (São José de Ribamar). d) Historical heritage of downtown São Luís.

Finally, (Fig. 7) shows structural changes in a natural landscape of coastal dunes in the north of the municipality of Raposa, As can be seen, it is a fragile landscape. The steady increase in tourism is a major factor of deterioration.

Fig. 7 Changes in the structure of the natural landscape through pollution of resources, degradation, disorderly process of occupation, predatory use of resources and tourism. Municipality of Raposa.

4 Conclusion

This work has focused on organizing and documenting a set of data and graphic information necessary to assess the evolution of the landscape in the studied field. Therefore, we have an information system that enables effective responses for proper planning.

Obtaining graphics, drawings, maps and images through the use of certain spatial infrastructures (SDI), mainly located in Brazil; seem to presenting some of the problems that may be related to accessibility to today. Problems related with permissions of network, digitization or simply availability permits have been so decisive and limiting factors for the implementation of a system such as that proposed. There are countless data, information or studies that can be found in the network or in bibliographic consultation on the studied space funds dispersed way. It is an island and a city with a heritage and unique cultural landscapes. The heritage built over the past four centuries, mainly in São Luis, first with then French and Iberian influences, gives the whole a singular value. Since colonial times the Tupinambás or old settlers began a modeling process of the landscape through fishing and farming, practices such as cultivation of cassava and sweet potato.

This work at this stage provides an organized information system based on a methodology so proven and innovative as proposed by Professor Steinitz [9]. For comprehensive planning should converge on the proposed scales data from four municipalities. Therefore, from representation to the decision-making, observing processes, evaluating changes and trends, quantifying impacts.

Integrate all this information and at the same time arrange it so that it is useful is a challenge. With this work we tried to lay the foundations so that the generated system can be called as an expert in heritage and cultural landscape of the island of Maranhão.

One of the main determinants of the current landscape is high human concentration in certain areas and the strong growth of the population in the past 50 years. Another decisive factor for the whole State of Maranhão is the opening to the sea, navigation over time, an Amazon geography.

Acknowledgement

I give thanks to the National Council of Scientific and Technological Development (CNPq/BRASIL) by grade scholarship abroad by science program without borders. I also want to give thanks to all the professionals of the research group GESyP for the help and strength given to make this work. Finally, I want to remember my grandmother rest in pace (RIP) forever rely on my.

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